

ENERGY STORAGE TECHNOLOGY SUMMARY

Presented to NASA EPFD Battery Day



Dr. Jason Nye
CEO at LAVLE
International relations,
trade, and investment
executive with more
than two decades of
commercial and
government
experience
Investment, JV
creation totals over
\$55 billion.



Morten
Pedersen
COO at LAVLE
20 years' experience
within the marine
industry. Marine
Engineering background
combined with Business
Development and
International
Management experience.



Dr. Ben Gully
CTO at LAVLE
PhD in Naval Hybrid
Power Systems, 6 years
as Lithium ion battery
subject matter expert
at DNV GL, including
technical guidance on
maritime safety
requirements.



Hiromichi Aoki
Advisor at 3DOM and
Director at LAVLE
Former Representative
Director and Senior
Managing Executive
Officer at Kawasaki
Kisen Kaisha, Ltd (aka
"K" line).



Kanamura
CTO at 3DOM and
Professor at Tokyo
Metropolitan University.
Pioneer in the
development of Lithium
battery technologies
holding hundreds of
patents in this field.

Dr. Kiyoshi



Shusuke Oguro
Former director of
Lithium-ion battery
divisions at Matsushita
Electric and Panasonic.
Launched the
manufacturing plant
that supplies battery
cells to Tesla commonly
known as the
"Gigafactory."



Toshiya

Kuwamura
Former General
Manager of Panasonic
Micro Battery Division
and responsible for
Panasonic's worldwide
network of battery
plants. Over 30 year's
experience with Lithium
batteries.



LAVLE

Located in Burlington, WA







Offices and Manufacturing - 22,000 sqft

Engineering R&D Center - 28,000 sqft











RAIL



TRADITIONAL LIB SYSTEM AVAILABLE NOW: PROTEUS



SUPERIOR QUALITY

- Blind mate connections no arc flash, worry free commissioning
- Redundancy at all levels of system provides maximum uptime
- 5 minute service time no tools, all data hard coded

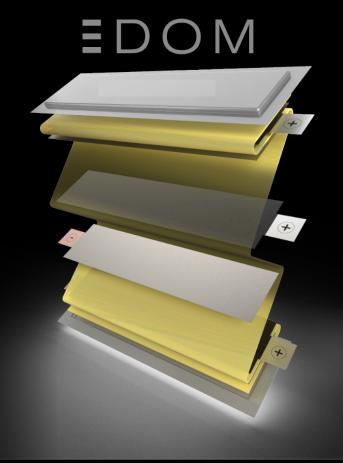
SUPERIOR BMS

- Dual redundant voltage monitoring *industry first*
- Highest performance balancing system in the market

SUPERIOR SAFETY

- Liquid cooling system *eliminates* thermal runaway
- Gas and leak detection in each module *industry first*

- Increasing energy density is the game changer
- This doubles what we can do in the battery applications of today
- Further, this opens up whole new industries and applications to be able to electrify and use battery technology
- The lithium metal anode is the key component for the next generation of batteries

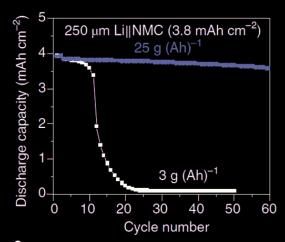


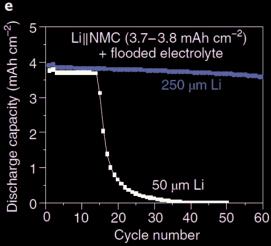




- 3DOM gets its name from a specially formulated and patented separator technology
 - 3 Dimensionally Ordered Macro-porous
 - Uniform current distribution
 - Dendrite suppression
 - High temperature stability
 - Improves efficiency and cycle life
- Able to be used in production processes of today
- Performance benefits for all batteries, and key enabler of lithium metal anode

- Solutions need to be proven in full, large format batteries not lab results of coin cells
 - Coin cells have relatively unlimited amounts of electrolyte and lithium metal to consume
- So the key is to demonstrate the claimed energy density in a large format battery with substantial cycle life (>60)
- Energy density targets
 - Proof of concept: 300 Wh/kg
 - Next level of performance: 350+ Wh/kg
 - Reference: Liu, Dufek, Goodenough, et al "Pathways for practical high-energy long-cycling lithium metal batteries", Nature Energy, 2019
 - https://doi.org/10.1038/s41560-019-0338-x





- Required proof of concept benchmarks
 - Large format cell
 - > 350 Wh/kg
 - Operating at < 45°C
- LAVLE lithium metal batteries have already achieved the required benchmarks
 - Large format cell
 - 420 Wh/kg
 - Operating at 25°C (room temperature)
- Continuing to make performance improvements as we move towards volume production



PERFORMANCE METRICS ACHIEVED IN LARGE FORMAT CELLS, READY FOR VOLUME PRODUCTION



